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INDEX TO CONTENTS

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Education

IN the flying at present being done in the this country heavier-than-air types of aircraft predominate. Machines of this type are being used for three kinds of flying, (1) Service (2) Air Mail and (3) Commercial. Compared with service and air mail flying, commercial flying occupies a minor position. It will continue in this position until public support is forthcoming but public support will not be forthcoming until the public is educated to appreciate the advantages of commercial flying. As commercial flying cannot afford to educate the public, this must be done by either service or air mail flying or both.

Service flying should not be permitted to educate the public for the era of aerial transportation. Education in how not-to-fly commercially will be easily acquired from observation of service stunts by the public. The fore-going statement does not disparage service flying, our service flying bids fair to be one of the finest both in material and personnel. We must realize, however, that service flying and commercial flying differ greatly, and therefore, should not be confused. Accidents to the former should not be used as a basis for condemnation of the latter.

The machines used in service flying are built to do work which no commercial machine will ever be required to do. Service pilots are trained and expected to perform in a manner which would be suicidal to commercial pilots; not to mention their passengers. It is not right, therefore, that the public should be permitted to base its opinion of aeronautics as a method of commercial transportation on the performance of service machines and pilots in the course of their duties. Since commercial flying, in its present state, cannot afford to educate the public, and since service flying should not be permitted to do so, the logical educational agent is the Air Mail Service.

For several reasons the Air Mail Service is in a position to carry on the education of the public in the advantages of aeronautics. The resources of the government support it, the air mail statistics show that it pays and there are many ways in which it can come constantly before the public. The Air Mail Service has realized its possibilities in this work, but not its responsibilities. The system as devised is good, but the method of operation is poor. Thus we have converted war machines, some of them obsolete, doing air mail work. This despite the fact that recent developments in aviation show success to follow the efforts of those who use machines built for the work to be done. The Air Mail Service must realize the responsibilities it possesses in the matter of preparing the public for the support they are bound to give commercial aviation, and bear these responsibilities in a manner becoming the great service into which it will eventually develop.

The Value of Air Transport

THE cancellation by the Post Office Department of the mail carrying contract by private airplanes between New York and Chicago via Pittsburgh, and the abandonment of the New York to Washington air mail route are regrettable setbacks to the progress of commercial aviation. The discontinuance of the St. Paul to St. Louis air mail route is threatened unless Congress at once passes a special appropriation which would permit the continued operation of this line.

While the practical value of the Washington- New York air mail route has often been questioned because of the extremely short distance it serves, no such argument can be held against the St. Paul-St. Louis line, which is over 600 miles in length and has proved of great value to business interests. Therefore, Congress should promptly authorize the necessary appropriation that will prevent a further curtailment of air mail activities.

In connection with this question of air mail routes, it seems necessary to point out the primary significance of air transport. Until night flying is generalized, air transport will not be fast enough to compete profitably with the highest type of existing communications, such as the transcontinental railways. But, on the other hand, air transport is so much faster, even without night flying, than the second and third rate means of ground communication and sea travel, that its practical value in such kind of competition cannot be questioned.

It follows that air transport lines—and air mail routes, too—should be organized to supplement deficient means of ground communication and sea travel, instead of trying to compete with the highest type of existing long range traffic. Thus, for instance, there seems to be a distinct place for an air line from New York to New Orleans and Laredo, whence it could eventually be extended to Mexico City. Ground communications on this route are slow and suitable commercial airplanes could cut the time of transit materially.

Another point worth mentioning is that such a line need not be run on a daily schedule to begin with, for the volume of passenger and freight traffic would not warrant it. A two-weekly or three-weekly service would very well answer the purpose at the start. The habit of comparing air lines to railroads seems to have brought about an obsession that air lines must be run on a daily schedule to be patronized at all. This, we believe, is a mistake. Air lines should be considered as a steamer service rather than a railroad service, and the frequency of the traffic should be determined by its probable volume and not by the dead letter of "one return flight a day". Steamship operators could probably give more valuable pointers on how to operate an air line profitably than could railroad men, for steamships possess like aircraft, a certain flexibility in operation which railroads lack.

The Home of the Martin Bomber

A visitor on entering the Martin factory is instantly imbued with the feeling that it is a workshop of the mastercraftsman—that here undoubtedly are men whose life work has been and will continue to be the production of Martin airplanes—men to whom the airplane is a vital, living thing, growing to perfection within their hands and minds, and worthy of their very best efforts because of the service it is destined to accomplish.

The plant may be visualized from Fig 1—the excellent site, the model landing field, the broad well-lighted buildings and the modern and complete equipment, but one can never really appreciate how remarkable is the "Home of the Martin "Bomber" until having come into contact with the founder and organizer of the company which so worthily bears his name.

First Factory in 1909

Mr Martin is a man who had the courage to devote every ounce of his brains, time, money and talent to aviation even before it was an industry. No amount of ridicule or skepticism could swerve him from his vocation—he believed in the airplane. Thus "Faith and Works" has raised him from an obscure inventor to one of the most prominent men in the aircraft industry today. His first factory was an old church building in Santa Ana, Calif., established in 1909. He was president of the company—and also part of the factory personnel. Today he is president and owner of The Glenn L. Martin Co. of Cleveland, with an organization numbering 420—and his plant is one of the finest in Cleveland

What has been the secret of Mr Martin's success in the face of obstacles considered insurmountable to the average business man? First, his indomitable perseverance, and second, his genius for organization Mr. Martin has always contended that the value and productiveness of any enterprise cannot be measured by the "brick and mortar holdings", but by the individual experience, ability and enthusiasm of the personnel. He has gathered about him men of exceptional ability, specialists in their particular lines who are known throughout the aircraft industry.

The romance associated with airplanes creates in the Martin plant a unique working atmosphere—each workman feels that he individually is a pioneer, that his work is contributing in a very vital and real way to progress. The concrete evidence of that intangible something termed Martin "shop spirit" is exemplified by the Martin Men's Club. This organization was founded in 1919 by a group of the employes and it has since grown to over two hundred members. The club meets every two weeks to enjoy a recreational or educational program The policy of the club is controlled entirely by its officers and directors who are elected from the membership at large

One Bomber a Week

Every eight days a huge twin motored six-ton bomber is completed at the Martin plant, test flown and delivered to Langley Field, Va. Of the twenty bombers now being built for the Air Service the last plane is scheduled for delivery June 9—forty days in advance of the contract delivery date. That the Martin Bomber has won the favor and confidence of the Air Service pilots is briefly summarized by a dispatch from the Aberdeen Proving Grounds printed in the Air Service Official News Letter. "The Martin Bomber may not be classified as a pursuit type of airplane, but it seems to be able to pursue until the pursuit plane comes Pilots at this station have recently looped and spun the big bomber."

The Martin factory is a specially designed pavilion type steel, brick and glass structure of 72,000 sq ft. floor space, situated on one end of a L-shaped flying field containing 70 acres of land, in the heart of the East End Cleveland manufacturing center, and is, of course, within easy reach of a large skilled-labor market

A complete Engineering Department is maintained for the designing, engineering and production of working drawings of Martin planes. The engineering staff includes a large number of technically trained men of long experience in automotive industries, many of them having devoted themselves entirely to airplane design and construction.

This department produces complete working drawings from which the planes are manufactured Tolerances for all dimensions are carefully studied and indicated on the drawings, leaving nothing to the opinion of workmen. Blue printing apparatus is installed within the Engineering Department which facilitates delivery of blue prints to the manufacturing organization Every airplane part to be produced is separately designed and released by this department

In addition to specializing on airplane engineering and design, this organization cooperates to the greatest possible extent with the Army and Navy of the United States government in developing the airplane as a military factor

Upon receipt of blue prints, specifications and releases by the Planning Department, the functioning of the production organization begins. This department calculates the quantities of raw materials and standard supplies required; issues detail shop orders to the various factory departments, and keeps a continuous production record of each and every job.

Specialized Tool Designers

The tool designers are technically trained men with experience in all branches of production tooling related to airplane manufacture Before orders are issued to the shop for production of any parts, the blue prints are carefully studied by them Then such tools as are considered advisable for the accurate and economical manufacture are designed by the department. Its function also is to prescribe the method of manufacturing all parts. To insure perfect interchangeability of the various parts and units, all assembly fixtures necessitated by economy are also designed here

Under the jurisdiction of the Treasurer is maintained a Cost Accounting Department which accumulates all production costs of orders issued from the Planning Department.

It is interesting to note that the company has a well organized fire department, the members of which are from the various departments and are drilled in the use of the equipment supplied for the protection of the company's properties. The factory has the usual sprinkler system installed, with a 50,000 gal reserve water tank; also, chemical extinguishers are installed in the various departments.

A well regulated cafeteria is located in the center of the factory where meals are served to all employes at cost. The cafeteria management also conducts a cooperative service for purchasing groceries in large quantities which are sold to employes at cost.

The entire factory and its equipment has been so laid out that plant departments can be expanded, with practically no disturbance to the existing departments, at a minimum cost.

The accompanying illustrations show the various departments of the Martin plant.

The Metal Department (Fig. 2)

(1) A group of five milling machines are shown here milling structural steel parts for Martin Bombers. A large stock of high-speed cutters is maintained for machining alloy steel.

(2) Cleveland automatic screw machines, with all attachments, sizes ½ in., ⅞ in and 1¼ in. are in constant daily use manufacturing alloy steel airplane bolts, tie rod clevises and clevis pins. These machines permit large quantity production with resultant minimum cost.

(3) Here we see five operations in the manufacture of axles for the Martin Bomber (MB2) These axles, however, must pass through ten or more operations before being completed.

(4) All metal fittings are assembled in the Metal Parts Assembly Department. Many special tools, fixtures and gauges are required in assembling the various metal fittings. Through tooling, the work of this department is placed on a high-speed production basis.

(5) One four-spindle upright and ten Allen single spindle

FIG 1 (1) GLENN MARTIN PLANT AND AIRDROME, (2) THE MARTIN BOMBER MB-2; (3) AND (4) AERIAL VIEWS OF THE MAIN FACTORY BUILDING

drilling machines used in connection with thousands of special drilling jigs, expedite and reduce the cost of drilling operations. Other heavy duty machine tool equipment installed in the Machine Shop, including engine lathes, arbor presses, shapers, punch presses, disc grinders, heavy sheet metal shears, and a large heavy duty square shear capable of cutting ¼ in. material, are used constantly in the manufacture of special metal parts.

(6) A highly specialized and completely equipped Tool Room is largely responsible for the economical and accurate production of all-metal and wood parts. Hundreds of special assembly fixtures that decrease assembly labor and that make interchangeable all of the assemblies on each model, are made here Only expert and experienced makers are employed. The equipment consists of milling machines, shapers, filing machines, lathes, drill presses and Universal grinding machines—all complete with the various special attachments.

After years of experimentation in designing tools for air-

FIG. 2 THE METAL DEPARTMENT

plane manufacture, a unique system has been developed for making fittings with absolute accuracy and at minimum cost.

The Wood Department (Fig. 3)

(1) All parts required for the production of wings for Martin Airplanes are delivered to the Wing Assembly Department in parts of unit assemblies, and are ready for assembly. Ribs are made up complete on the rib assembly jigs and are designed so that they may be slipped along the wing beams in place, thus saving a great portion of the time required in the usual method of building up ribs in wing assembly.

(2) Special assembly jigs have been developed for Wing Rib Assembly. Their use facilitates rapid production, insures accuracy and minimizes production costs. The jigs are of all-metal construction and are mounted on a special table at the back of which is a rack containing all of the members used in the rib.

(3) The temperature and humidity of the Glue Room are under perfect control at all times. The consistency of the glue is checked hourly, and samples of every lot of gluing are tested. A specially designed press, 30 feet in length, is used exclusively for gluing struts and all other important structural members.

(4) The Mill and Cut-up Plant is completely equipped for

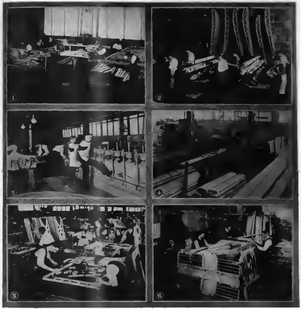


FIG. 3. THE WOOD DEPARTMENT

the fabrication of all wood parts required in the manufacture Martin airplanes. Practically every part, from the large wing beams to the minute pieces, are completely fabricated by machinery. It is only a matter of assembling the various wood structures after the parts have left the mill.

(5) Hundreds of specially designed fixtures are used to facilitate the assembly of the many wooden frames, such as bulk-heads, turtle backs, floor units, etc. Only experienced cabinet and pattern makers are employed for this work, which requires great exactness and skilful handling of tools.

(6) Every separate wood part and assembly is carefully checked in the Inspection Department for quality of material, accuracy of dimension and workmanship. Each detail part is stamped with its part number, and must bear the inspector's O.K. before being used.

The Assembly Department (Fig. 4)

(1) All major units of Martin airplanes are as nearly completed as possible before they reach the final assembly floor. They are usually scheduled to arrive in the Assembly Department in sets. Three different crews under three separate sub-foremen handle the final assembly of each Martin Bomber, the entire Assembly Department being under the supervision of one general foreman. The first of these three crews assem-

Fig. 4. The Assembly Department

ble the entire top wing, hoist it on specially designed apparatus, attach fuselage, lower wing panels ,tail surfaces and landing gear.

(2) At this stage of construction the machine is moved forward to its next position, where wings and control surfaces are properly aligned, motors installed and the installation of other units completed.

(3) In the Parts Assembly Department all special and distinct units, such as steering columns, landing gears, bomb sight brackets, etc., are assembled.

(4) In the Finished Parts Stock Room records are kept of all finished parts throughout the plant. However, only the surplus of finished parts above daily production requirements actually enter this stock room. The majority of the finished parts are so timed as to go directly into the Assembly Department.

(5) The Fuselage Assembly Department occupies an area of 50 feet wide, stretching across the entire assembly floor. The assembly of fuselages begins on the west side of this department and works progressively across the floor. The frame of each fuselage is assembled on a specially designed steel table, which makes it convenient to form the curves of the longerons and to maintain and check the proper alignment of the frame. After each fuselage is assembled, the various parts

Fig. 5. The Special Departments, I

and units previously assembled are installed, at the conclusion of which, the covering, doping and finishing operations follow.

(6) After each plane is finally assembled both motor and flight controls are connected and checked. The machine is then filled with gas, oil and water, and the motors are ground tested to check installations. The plane is thus completed and ready for test flight.

Special Departments (Fig. 5)

(1) The Covering, Finishing and Doping Departments are under the supervision of a general foreman. For the most part, women are employed to sew the cloth and apply the covering to the frames. This department is thoroughly equipped with special and standard apparatus for the speedy and economical accomplishment of the work in accordance with Government specifications. Double needle sewing machines are used in sewing all of the large wing coverings.

(2) Doping and finishing are accomplished both with hand and air brushes. Painting of parts is done by dipping and air brush methods, the inside of all tube parts are filled with paint under pressure in accordance with government specifications.

(3) The Physical Laboratory is equipped with the necessary special and standard apparatus to test all material going into

FIG. 6 THE SPECIAL DEPARTMENTS, II

the construction of Martin Bombers. The required number of samples of every kind of material used in the construction of the Bomber are tested from each lot. The routine work of the Physical Laboratory includes complete physical tests of metal bars, sheets, wires, cable and tubing test bars representing metal castings, wood specimens and miscellaneous material.

(4) A required number of samples of all metallic materials used in the construction of Martin Bombers are chemically analyzed to determine their suitability for the purposes intended. In addition to the routine tests made in the Chemical and Physical Laboratories, in connection with production, these departments also work in cooperation with the Engineering Department investigating experimental ribs, experimental box type wing drag struts, fittings, bulkheads and other important units of airplane construction.

(5) and (6) All motors prior to their installation are completely conditioned and block tested to determine their full rate of horsepower, and to see that all ignition, fuel and gas systems function properly.

Special Departments (Fig. 6)

(1) All wing panel frames and like structures are given the necessary number of coats of varnish with an air brush in a specially constructed cabinet with forced ventilators. This method of applying varnish is far superior to the hand method because the varnish is applied in a more uniform manner.

(2) The first step in the wood production of the Martin Bomber is the selection of the best airplane lumber obtainable. After every square foot of wood has been thoroughly inspected it is arranged on trucks, as indicated in this picture, placed in the *Dry Kiln*, and dried to Government specifications from 45 per cent moisture to 6 per cent in twenty-two days.

(3) All small parts, such as bolts, nuts, cotter pins, nails, brads, etc., are thoroughly cleaned in a tumbling barrel and are then zinc plated. The steel plating tanks are sufficiently large to accommodate the long steel members. All steel parts used in Martin airplanes are carefully plated by the electro process.

(4) *The* Sheet Metal Department, where tanks, cowling, streamlines, and other tin and aluminum parts are manufactured, is well equipped, including in its equipment a four-foot power gap shear and an eight-foot brake, rolls and groving machines. Only expert tin and copper smiths are employed, thus insuring the highest grade of sheet metal work.

(5) A Sand Blasting Department is operated in connection with the Zinc Plating Department. The sand blast room is eight feet square with doors on opposite sides to permit sand blasting of extremely long parts for electro zinc plating, but also reduces considerably the cost of cleaning fittings after brazing and welding, which is usually done by hand.

(6) In the Brazing, Welding and Heat Treating Department is found the most modern equipment for torch brazing, dip brazing, oxy-acetylene welding and electric spot welding. In many cases, fittings for Martin Bombers are treated with three of these operations, namely, electric spot welding, oxy-acetylene welding and dip brazing. A special furnace is provided for the scientific heat treatment of all metal parts that require heat treatment.

Generals Menoher and Mitchell Honored by Italy

The Italian Ambassador, Senator Rolandi Ricci, has conferred upon General Menoher, Chief of Air Service, and General Mitchell, Assistant Chief of Air Service the Commenda of Saint Maurizio and Lazzaro by direction of His Majesty, the King of Italy in recognition of the distinguished services rendered to Italian Aeronautics.

The ceremony took place at the Italian Embassy and it was attended by Generals March, Wright, Haan, Jervey, Nolan, Colonel Buckey of the Army Intelligence and Commander Henderson of Naval Intelligence. Many officers of the Air Service Staff were present together with all Air and Military Attache's of Allied Powers.

Turbulence in the Air Tubes of Radiators

N.A.C.A. Report No. 106

The existence of turbulent flow in the air passages of aircraft radiators and of variations in character or degree of turbulence with different types of construction is shown by the following experimental evidence:

(1) Pressure gradients along the air tubes are roughly proportional to the 1.7 power of the speed, which is characteristic of turbulent flow in long circular tubes of the same diameter.

(2) The surface cooling coefficients of radiators vary widely (0.002 to 0.007) when expressed as heat dissipated per unit time, per unit cooling surface, per unit temperature between air and water, and at given average linear speed through the tubes.

(3) A fine wire electrically heated shows different cooling coefficients in the air tubes of different radiators.

(4) Temperature gradients in the air tubes are of the form characteristic of turbulent flow and fail to show sudden breaks such as might indicate a dividing line between regions of viscous and of turbulent flow.

The use of special devices for increasing turbulence may increase the heat transfer per unit surface for a given flow of air through the radiator but such practice decreases that flow for a given speed of flight and increases head resistance. At very low flying speeds, or in cases where the radiator is mounted in the nose of the fuselage, turbulence devices may sometimes be used to advantage, but every type known to the writer is detrimental to the general performance of the radiator at high speeds.

A copy of Report No. 106 may be obtained upon request from the National Advisory Committee for Aeronautics, Washington, D. C.

Fokker F.III for W. S. Aircraft Corp.

C. H. Messer of the W. S. Aircraft Corp., of Spokane, Wash., has purchased from the Netherlands Aircraft Mfg. Corp., of New York, a Fokker F.III 6-place commercial airplane. The machine is expected to arrive in New York from abroad about July 1, after which it will be flown across the continent to its destination.

Book Reviews

AIRPLANES AND SAFETY. (The Travelers, Hartford, Conn. 127 pp., 27 ill.)

It is gratifying to see an insurance company of the standing of The Travelers go to the expense of bringing out a book for the sole purpose of educating the public with regard to the safety of aviation. It not only proves that underwriters realize that air navigation is here to stay, but also shows their desire to hasten its growth by informing the layman of the actual facts.

The book is a sound, non-technical discussion of airplanes and their relation to commercial flying, which is primarily meant for the business man who has enough foresight to grasp the great future of air navigation and wishes to gather facts expressed in every day language. Since the publishers naturally consider airplanes in their relation to safety, a few comments on this subject will not be amiss.

In considering cabin airplanes, especially those alighting on the water, attention should be paid to providing easy emergency exits. Some commercial machines are quite unsatisfactory in this respect, the only possible exit consisting of one door on one side of the fuselage. If this single door should be obstructed in a crash, it is obvious that the passengers would be trapped.

The procedure for starting the engine, described on p. 40, does not mention that most important instruction "Switch off", neglect of which would cause disaster to a mechanical starter, not to mention a human one.

"A well arranged airdrome", illustrated on p. 84, could be improved in the interest of safety by the removal of the huge water tower which can be seen obstructing the approach to one side of the airdrome.

The licensing of pilots is called attention to on p. 88, but no mention is made of the licensing of aircraft for airworthiness—a requirement which is just as necessary as is the licensing of buildings and bridges. Energy expended in spinning prospective pilots on whirling chairs could well be devoted to preventing machines of doubtful age and strength from going up and shedding various parts on the ground.

Wireless equipment will be of inestimable value for informing pilots of weather conditions along the route to their destination.

Fuller consideration of the subject would have compelled the authors to mention amphibian machines, on p. 95, as a means of preventing the delays now prevalent in getting from airdromes to city and vice-versa. Taking the case of New York alone, an amphibian could reach the very heart of the city, just as do seaplanes, and still fly over land.

Beyond lacking these points, the book is well arranged. It is attractively printed with a glossary and index, and is a credit to its publishers. Business men will learn much from reading it.

Airplane Perfomance and Design Charts*

By L. V. Kerber

Aeronautical Engineer, Engineering Division, Air Service

Rate of Climb Chart

Rate of climb at zero altitude, high speed at zero altitude, and absolute ceiling are all functions of the three variables, lb./hp., lb./sq. ft. and "fineness". For a given set of variables the three above mentioned characteristics of performance are definitely fixed. High speed and absolute ceiling are already expressed as functions of the variables and hence rate of climb can be expressed as a function of speed and ceiling. The criterion for rate of climb can be shown to be the product of absolute ceiling and high speed at zero altitude. Proceeding on this theory and solving the relation from results of the previous chart listed in Table I, the curve of rate of climb at zero altitude has been constructed in Fig 3. In general, there should be constructed each a curve for each particular

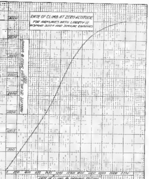


Fig 3

engine, but in the present instance it has been found that the curves for airplanes with the Liberty 12 and with the Hispano-Suiza 300 are practically coincident, and no separation has been made.

The nature of the rate of climb curve of Fig 3 can readily be understood if the horsepower available and horsepower required curves of an ordinary power-velocity chart are borne in mind. The lower part of the curve is characteristic of the condition of high horsepower loadings and low "fineness". In this case an increase in horsepower available means a certain increase in rate of climb, but proportionately smaller increases in both absolute ceiling and high speed, so that the product of the latter two, if plotted against rate of climb, will be a curve of the nature of a straight line. The upper half of the curve is characteristic of the condition of low horsepower loadings and high "fineness", in which case the rate of climb again varies directly with the horsepower available, absolute ceiling is very nearly proportional to the same, and high speed at zero altitude is proportional to the cube root of horsepower available. Thus rate of climb increases faster than the product of absolute ceiling and high speed and the curve changes from a linear function to a semicubical curve at it upper half. Values above 2000 ft./min. were found by extrapolation, and should not be considered accurate in Fig 5.

Time of Climb

Rate of climb may be assumed to be a linear function of altitude. *Since we have two points on the rate of climb curve, one at absolute ceiling where the rate is zero and one at zero altitude where the rate is found from Fig. 3, the curve may be drawn as a straight line joining these points. Time of climb to any altitude may be expressed as the integral of the rate of climb curve. Integrating and substituting the known values of absolute ceiling and speed at zero altitude, the following expression is obtained

(7) $t = 2.303\ C/R \times \log C/(C-B)$

where C = absolute ceiling (ft.)

R = rate of climb at zero altitude (ft./min.)

t = time to climb to any altitude B (min.)

This expression has been plotted in Fig. 4 in the form of an alignment chart prepared by the Flight Test Branch. Substituting in equation (7) or on Fig 4, the value of C from the speed-altitude chart and the value of R from Fig 3, it will be possible to find the time of climb to any altitude, B, and conversely, the altitude reached in any time, t.

Performance and Design Chart

Absolute ceiling and speed at all altitudes have been determined as functions of lb./hp., lb./sq. ft and "fineness". Rate of climb at zero altitude has been determined as a function of absolute ceiling and high speed at zero altitude, and time of climb has been expressed as a function of absolute ceiling and rate of climb at zero altitude. The speed-altitude chart of Fig 2 will serve primarily to determine the altitude functioning of various engine-propeller sets. Once this curve VI has been found for a particular engine, the chart of Fig 2 will serve as a basis, and the rate of climb chart of Fig 3 and equation (7) or the chart of Fig 4, will serve as auxiliaries in rearranging the material at hand to construct a performance and design chart, Fig 5, giving at once all the characteristics of performance and hence design, of airplanes equipped with the particular engine, in terms of the three fundamental variables.

If we start always at zero altitude at point 6 on the "h" scale of Fig 2, proceed always to point 7 of 0.80 engine propeller factor, thence to various points 8 of curves V corresponding to values of lb./hp. of 5-10-15 etc., thence to corresponding points 10 of "fineness" 100, thence to points 4 on the zero altitude line of curves II, thence in each case to points 3 of curves I corresponding to values of lb./sq. ft of 4, 5, 6, ... 20, thence in each case to the zero altitude line of curves III, thence to high speed on scale "d". We now have, for various lb./hp. and lb./sq. ft., and for "fineness" 100, the corresponding values of high speed at zero altitude. Fig 6, indicates the nature of the plotted data. Starting now, successively at any altitude on scale "h", proceeding through in the same manner as above indicated, except for using the proper altitude lines of curves II and III, we can plot, as represented in Fig 7, speed at any altitude as a function of lb./hp. and lb./sq. ft.

It has been shown that for any altitude, engine, lb./hp. "fineness", and lb./sq. ft., if the line 14-13 is just tangent to the lb./sq. ft. curve, that altitude is the absolute ceiling. To express absolute ceiling in terms of the three variables, start with various lines 14-13 tangent to each of the lb./sq. ft. curves, choose points 14 at various altitudes, let point 15 always be on "fineness" 100, draw lines 15-16, choose points 18 at various altitudes, erect perpendiculars from points 20, and the intersections with line 15-16 will give various values of lb./hp. which correspond to the particular lb./sq. ft., and altitudes which are absolute ceilings. Curves of the nature of those shown in Fig. 8 are obtained.

If lines 13-12 are dropped from the points of tangency of lines 14-13 with the lb./sq. ft. curves, and points 12 chosen at various altitudes, then points 11 will be high speeds at these altitudes, or absolute ceilings. For any particular lb./sq. ft. and absolute ceiling, we have found the lb./hp. above, so that now we can plot the speed at absolute ceiling against lb./hp., and lb./sq. ft. as shown in Fig 9.

If for various lb./hp. and lb./sq. ft. we take the proper values of high speed at zero altitude from Fig 6 and absolute ceiling from Fig 8, and determine the rate of climb at zero altitude from Fig 3, it can then be plotted in terms of the original variables as in Fig 10.

For various lb./hp. and lb./sq. ft., we have absolute ceiling from Fig 8 and rate of climb at zero altitude from Fig. 10. Using the construction shown in Fig 11, we find various service ceilings (where the rate of climb is 100 ft./min.) which can be plotted in terms of the variables. See Fig. 12. Choosing now from Fig 12, various values of altitude or service ceiling, and the corresponding lb./hp. and lb./sq. ft., we can find from the speed-altitude chart of Fig 2, the high speed at

* Concluded from our last issue

* 'The General Theory of Steady Motion', Dr G. de Bothezat. National Advisory Committee for Aeronautics.

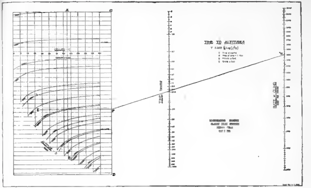


Fig. 4

Fig 5

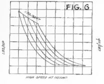


FIG. 6

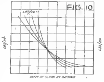


FIG. 10

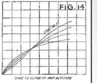


FIG. 14

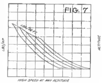


FIG. 7

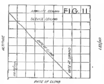


FIG. 11

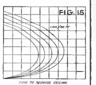


FIG. 15

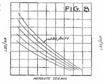


FIG. 8

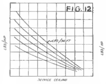


FIG. 12

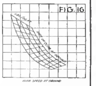


FIG. 16

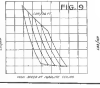


FIG. 9

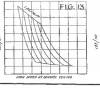


FIG. 13

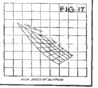


FIG. 17

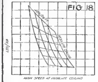


FIG. 18

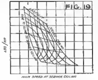


FIG. 19

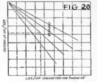


FIG. 20

service ceiling, which in turn can be plotted as shown in Fig 13

Suppose we choose, for various lb /hp and lb /sq ft. values of absolute ceiling from Fig 8 and of rate of climb from Fig 10, then by substitution in equation (7) or using Fig 4, we can find the time to any altitude as shown in Fig 14. Time to service ceiling can be found in the same manner by substituting in addition, values of service ceiling from Fig 12 as the altitude B in equation (7) See Fig 15

Now we have separate charts of all the main performance characteristics as functions of lb /hp and lb /sq ft. However it is desirable and possible to reduce the number of figures by combining them according to the different altitude regimes. At zero altitude, the rate of climb curves of Fig.10 can be superposed on the high speed curves of Fig 6 and we have a chart such as Fig. 16 Again, at as many altitudes as desired the time curves of Fig 14 can be cross-plotted onto the speed curves of Fig 7, as shown in Fig 17. Next, service ceiling from Fig 12 and time to service ceiling from Fig 15 can be superposed on the speed at service ceiling curves of Fig. 13, with the result shown in Fig 19 Finally, the absolute ceiling curves of Fig 8 are cross-plotted on the speed at absolute ceiling curves of Fig 9, as shown in Fig 18.

In Figs. 6 to 19 the lb /hp scale corresponds always to a "fineness" of 100, so that if we wish to introduce the effect of "fineness", it is only necessary to construct a chart as shown in Fig 20, where the horizontal scale is the actual lb./hp and the vertical scale is the lb./hp. corrected to an equivalent lb /hp of the basic airplane

The performance and design chart, such as is shown in Fig 5 for airplanes with the Liberty 12 engine, may now be constructed for airplanes with any engine, by combining the charts of the nature indicated in Fig. 16 to 20, so that, given the weight, area, horsepower, external characteristics and hence "fineness" by comparison with the airplanes of Table I, it is possible to determine in a few moments the complete performance of the airplane, i.e., time, rate and speed at all altitudes. When no chart such as Fig 5 has been previously constructed for airplanes with a particular engine, it will be necessary to choose such a chart for an engine with similar characteristics.

From the standpoint of design—the selection of the weights and area of an airplane of given engine power and external characteristics, necessary to fulfill a certain desired performance—a chart of the nature of Fig. 5 should prove of distinct value. The procedure in determining performance from Fig. 5 is to start at the lb /hp. at the ground scale, erect a perpendicular to the proper "fineness", and then draw a horizontal line to the right which will intersect in turn each of the remaining sets of curves. The intersection of this line with the proper lb /sq ft. line will on each set of curves indicate the particular items of performance. For purposes of design, the converse procedure will be used. For instance, suppose that the external characteristics, hence "fineness", and the engine power at zero altitude are known and that the lb /sq. ft. is fixed by landing speed considerations, as it always is. Further, the airplane in question is desired to fulfill a certain performance, speed, time or rate at a certain altitude. If we find on the proper altitude set of curves, the intersection of the lb./sq. ft. line with the proper item of desired performance, draw a horizontal line to the left to the proper "fineness", a perpendicular to the lb /hp. scale will indicate the lb /hp. necessary. From this value and the known engine horsepower, the total weight is determined, and from the total weight and the known lb /sq. ft., the proper area may be found. Likewise, if the high speed at zero altitude, the lb /hp and lb./sq ft., of an airplane are known, the chart of Fig 5 will serve as a means of determining "fineness". If the chart is constructed for the particular engine of an airplane, then any known item of performance together with lb /hp. and lb /sq. ft. will serve to determine "fineness".

Conclusion

It can be shown that high speed at the ground is practically proportional to the cube root of L/D. The "fineness" factors of Table I, which are exactly the cube root of the relative L/D, are then a direct measure of the percentage of error which may be expected from using past charts of purely empirical nature, based on lb /hp and lb./sq. ft. alone. The "fineness" factors of Table I vary from 91 to 116 so that the error above mentioned may be as high as 25 per cent.

The author has done considerable work along the lines of purely theoretical analyses of performance, and is convinced that, due to paucity of experimental data, the "fineness" of an airplane cannot be computed with the accuracy with which it can be selected from Table I. As purely theoretical analyses

TABLE II. STANDARD ATMOSPHERE*

Standard Altitude	Temperature deg Cent.	Percentage Pressure	Percentage Density	$(1/\rho)^{1/2}$	$(1/\rho)^{1/3}$
0	15 00	1.000	1 000	1.000	1.000
1,000	12 84	.963	.972	.986	1.028
2,000	10.76	.930	.944	.972	1.060
3,000	8 71	.897	.917	.958	1.043
4,000	6 76	.866	.890	.943	1.060
5,000	4 81	.832	.863	.930	1.078
6,000	2.86	.802	.837	.915	1.096
7,000	1 14	.772	.811	.901	1.110
8,000	- 0 61	.744	.786	.887	1 128
9,000	- 2.90	.715	.761	.873	1 145
10,000	- 3.94	.689	.737	.858	1 164
11,000	- 5.82	.662	.716	.845	1 184
12,000	- 7 63	.637	.690	.831	1.206
13 000	- 8 63	.613	.667	.817	1.226
14 000	- 9 67	.589	.645	.803	1 244
15,000	-11.85	.567	.624	.790	1 267
16,000	-12.68	.545	.606	.776	1 289
17,000	-13.07	.524	.582	.763	1.310
18,000	-15.21	.503	.562	.749	1.332
19,000	-16.40	.483	.546	.736	1.353
20,000	-17.50	.463	.524	.723	1.383
21,000	-18 67	.446	.505	.711	1.406
22,000	-19 74	.429	.487	.698	1.433
23,000	-20 77	.412	.470	.686	1.456
24,000	-21 79	.396	.453	.673	1.483
25,000	-22 72	.380	.437	.660	1.510
26,000	-23 64	.365	.421	.649	1 541
27,000	-24 52	.350	.406	.637	1 572
28,000	-25 37	.336	.391	.625	1.600
29,000	-26 18	.322	.376	.613	1 632
30,000	-26.97	.310	.363	.603	1.660

Ground 15 deg. Cent., 29.92 in. Hg., 0.07608 lb. per cu. ft.

* Engineering Division.

are extended from the determination of the L/D curve to the computation of performance at altitude, errors and difficulties due to lack of experimental data on motor performance at altitude increase to such proportions that results are obtained so greatly at variance with full flight test results as to be practically worthless

It has been shown that the present empirical-theoretical method combines the advantages and avoids the difficulties of former purely empirical or purely theoretical methods of performance prediction, with a great saving of time over the latter and with a higher degree of accuracy than either It must be remembered that as the volume of flight test results increases, so will the length and diversity of Table I increase with the result that the exercise of proper judgment in selecting a "fineness" factor for a new airplane will continually be made easier and require less time.

To Attempt Non-Stop Flight Los Angeles-New York

David R. Davis, of Los Angeles, and Eric Springer, chief pilot for the Davis-Douglas Co. of that city, will attempt a non-stop flight from Los Angeles to New York late this month or early in July They will fly the Cloudster, a giant plane especially designed for the trip which will take them over the 2,500 miles airline separating the coasts. If they succeed in their attempt, they will have broken the world's record for distance in a non-stop flight made by Alcock and Brown in their 1940 mile trans-Atlantic flight in 1919, and also the world's duration record of 24 hours and 19 minutes held by the Farman Goliath. Davis and Springer believe it will require approximately 30 hours for them to reach New York without stopping enroute.

The machine was designed by Donald W Douglas, president of the Davis-Douglas Co of Los Angeles. It is a tractor biplane with a 400 h p. Liberty motor, and has a wing spread of 56 ft, is 35 ft long and stands 13 ft. from the ground Empty, it weighs 3,800 lb It is entirely of American design and construction, even the wing curve being of recent American development

The Cloudster is equipped with huge tanks holding 660 gal. or more than 2 tons, of gasoline. Fifty gallons of lubricating oil are also carried. This fuel, tests have shown, will carry the plane at a cruising speed of 85 m.p.h for 33 hrs., or 2800 miles.

The machine will carry big landing flares and rockets along with navigation lights and the latest instruments for flying at night. Each occupant will wear a parachute. The fuel tanks are so arranged that they may be released and dropped from the machine if a forced landing is imperative, thereby, by decreasing the weight, cutting down the speed to about 36 m.p.h. and enabling the plane to alight in a comparatively small space.

Davis and Springer plan to set out in the early morning of a day when the Weather Bureau reports favorable winds across the continent. They intend to rise to an altitude of 12,000 ft. over the mountains and hope to reach the plains of the Middle West that evening, following the route of the Santa Fe Railroad to Kansas City, and thence straight to New York, arriving at Curtiss Field, Garden City, Long Island before nightfall of the second day

Air Mail Changes

The committee of Post Office inspectors, working under the direction of the Chief Inspector, Rush D Simmons, who have been investigating the conduct of the Air Mail Service, made a preliminary report May 27 in connection with the situation at Checkerboard Flying Field, Chicago, in which they recommended the removal of Eugene W Majors, Superintendent, Air Mail Service, Chicago, S Murray Moore, Assistant Superintendent, Air Mail Service, Chicago; Paul L Dumas, Field Manager, Chicago; Carl Nickell, Purchasing Agent, Chicago, Paul B King and Daniel A Martin, Employees, Air Mail Service, Chicago

The investigation disclosed that there had been considerable incompetency in connection with this field. A permanent organization has not yet been selected for the Chicago Field, which at the present time is being handled by Carleton Parker, who formerly was in charge of the Repair Depot at Bustleton, Pa

The Chief Inspector is continuing his investigation of the Air Mail Service and will make final report within the next two or three weeks on conditions at other points. It is not thought, however, that there will be any further situations found wherein it will be necessary to take such sweeping disciplinary action as at Chicago

At the present time it is contemplated to discontinue the St. Paul-Chicago and St Louis-Chicago air routes at the end of June. When this is done it will restrict the Air Mail Service operated by the Post Office Department to the Trans-Continental route, from New York to San Francisco, which will be kept in operation during the coming year

When the Air Mail Service was first organized it was planned that it would be rapidly extended in various directions and the New York-Washington, St. Paul-Chicago-St Louis routes were to be parts of airways that would extend from the northern part of the United States to the southern part. At the present time, due to the need of economy and lack of necessary appropriations, no further extension of the Air Mail Service is possible, and on that account the Department does not feel justified in attempting to continue operating these short routes which are very expensive to operate and do not materially improve the mail service between these cities over service that is in effect on the fast trains, this in consideration of the fact that up to the present time it has not been possible to develop night flying to a point where mail planes can be operated at night.

THE U.S.S. SHAWMUT, HARDING AND SANDPIPER, TENDERS AND FUEL SHIPS FOR THE ATLANTIC FLEET AIR FORCE, AT GUANTANAMO, CUBA, DURING THE RECENT MANEUVERS

Airdrome Notes

With the ever increasing number of airdromes it is almost impossible to prevent some of them being manned by ground personnel having inadequate knowledge of the essentials of a safe landing field

Eddie Rickenbacker describes below an experience which he had during his recent flight across the continent when he landed at Cheyenne, Wyo, after sundown. He says

"A landing flare had been placed on the field. But it was at the wrong end of the field The T-shaped object, covered with burning gasoline, faced the wrong way I thought it was the beginning of the field. It was really the end. I had the wheels down alongside the T all right, but I was going in the wrong direction out into the rough country The D H. was wrecked I loosened my life belt and managed to crawl out"

It would not be a bad idea if airdrome managers would from time to time give their handling crews a brief course on how to display the landing T, where to light flares, what to do in case of a crash, etc On first class airdromes, where operating or manufacturing companies are managing the ground organization, the handling crews as a rule know their job On smaller fields, however, this is not always the case and the consequences are fraught with danger for the flier—just as Eddie Rickenbacker experienced.

Crete, Nebr

The little town of Crete, Nebr, has just established a municipal airport by a method which does credit to its foresightedness and enterprise When the question of an airdrome came up, it was decided to acquire the necessary site by means of a public subscription. Now the money has been subscribed in $25 shares and a lease has been signed for a 15 acre tract for one year, with the privilege of renewal for four years

The field is 650 ft running E to W and 1000 ft running N to S It will be marked in accordance with the Air Service specifications and telephone service will be available on the field The vicinity of the radio station at Doane should make this airdrome a desirable stopping point for transient fliers.

Evanston Field, Chicago

The Aviation Club of Chicago has inaugurated a new airdrome W of Evanston, Ill. The field is 160 acres in size and is equipped with several hangars, a club house, golf course and polo field. W. C Burmeister, former Air Service pilot, is in charge of the field and will conduct a flying school there.

Miles City, Mont

Miles City, Mont., has a very good airdrome near the town, with a hangar in one corner The field is large, flat and without obstructions, and houses three airplanes belonging to the Miles City Aero Club.

Hartford, Conn.

It should be noted in connection with information previously published in this column that the Hartford municipal airport will be available for seaplanes as well as for land machines. The Hartford Aviation Commission announces that four seaplane moorings are being put in place, about 200 ft off shore in the river, directly opposite the municipal airdrome. With these moorings seaplanes can anchor safely and will not be subject to danger in case of storms

Arkansas City, Kan.

Arkansas City. Kan, recently inaugurated its municipal airdrome, which is situated one mile N of the town The field, said to be one of the finest in the Middle-West, is equipped with a modern hangar 40 by 100 ft which can accommodate from eight to ten airplanes of medium size. The hangar also contains a machine shop. The field is now used by the William-Hill Airplane Co.

Packard Field, Detroit

Fire of indeterminate origin recently destroyed several sheds at the Packard flying field, Detroit. The damage is estimated at $25,000.

Sioux City, Iowa

Establishment of a commercial airport at Sioux City, Iowa, was forecast by Bert Price, counsel for the Curtiss Iowa Aircraft Co of Fort Dodge, in the course of an address he recently made before the Sioux City Rotary Club Mr Price arrived by airplane and took up several Rotarians for short flights. It seems likely that the field, for which a tentative location has already been found, will be opened in the course of the summer

Holdrege, Neb.

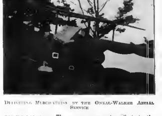
The Central Aircraft Company has opened an aviation school at Holdrege, Neb., and offers a comprehensive course in aviation embracing the theory of flight, construction and maintenance of machines, and time in the air for dual instruction and solo flying.

Pilots certificates are granted at the completion of the course

Oakland City, Ind.

An airdrome one half mile north of Oakland City, Ind., is maintained by the Oneal-Walker Aerial Service, and is at the disposal of all pilots.

This firm is engaged in advertising and merchandise and passenger carrying The accompanying picture illustrates the arrival of a recent shipment of merchandise from Evanston, Ind.



DELIVERING MERCHANDISE BY THE ONEAL-WALKER AERIAL SERVICE

Philadelphia

The need of a municipal airdrome at Philadelphia is aptly illustrated by the amount of flying being done at the airdrome of the Aero Service Corp just outside the city. The field is only thirty minutes ride by street car from the center of the city, and is quite an aviation center, having now four hangars and a gas and oil station.

W Wallace Kellett, representative for the well known French Farman airplanes is demonstrating the Sport Farman, and the Aero Service Corporation has two machines flying regularly. Excellent work in aerial photography is also being done by the latter organization.

The Philadelphia *Public Ledger* maintains a machine with pilot at the field for the purpose of securing news photographs or special stories.

Cincinnati

A new airdrome at Cincinnati, Ohio, was recently opened by O. W Pearson, ex-Air Service pilot, who intends to use it for passenger carrying and exhibition flights. The field is situated on Reading Road, near the Hamilton County Country Club

Dayton, Ohio

A new flying field has been opened at Dayton, Ohio, by Jack Stinson. The field is situated between the Canal and the Mad river, at Findlay and Valley streets.

San Francisco to Venezuela by Airplane

James Otis, president of the San Francisco exporting firm of Otis, McAllister and Co., left Redwood City, Calif., on May 15, bound for Caracas, Venezuela, South America, in his recently purchased Ansaldo SVA three place airplane.

Mr. Otis, a pioneer California aviation enthusiast and president of the newly formed San Francisco Aviation Club, is accompanied by his pilot, William Morris, formerly of the R.A.F., and "Slim" West, his mechanician. He contemplates traveling by airplane for four months through Mexico and Central America. Mr Otis, in the course of his business experiences during the last thirty years has covered all of the territory over which his plane will fly, and has mapped the following itinerary, based upon his knowledge of the country.

From San Francisco he will fly to Los Angeles, where he [illegible] Calif. By the time this news is published, Mr. Morris, who

Left to Right: Pilot W. Morris, Charles West, James Otis, President of the Aero Club of California

telegraphed to the Aero Import Corp. from Bagdad on May 25, will be at Phoenix, Ariz., from which point he will fly, through Tucson, to Guaymas, Mexico, and thence through Mazatlan, San Blas, and Guadalajara to Mexico City. The route from Mexico City southward across the Isthmus of Tehauntepec, has been mapped out, through Tapachula, Guatemala, Salvador, Nicaragua and Costa Rica. From the latter point Mr Otis proposes to fly across the Isthmus of Panama to Colombia, South America, and thence eastward to Caracas, the capital of Venezuela.

No attempt at speed will be made on the trip, and Mr. Otis plans a leisurely journey of about four months duration, during which he will see and meet his friends and business acquaintances in the various countries over which he will fly.

In the course of the flight it is expected that Lieutenant Morris will gather very valuable data on flying and field conditions in countries, which are almost unknown from an aeronautical standpoint. All landing places will be mapped, mountain courses and desert regions will be charted, and meteorological conditions will be carefully noted throughout the journey. Food and water are a part of the party's regular equipment, in case forced landings compel it to remain away from the centers of life in the very savage country which is being traversed, especially between Mexico City and Panama.

The Ansaldo airplane in which the party is making the trip, is the stock three-place imported by the Aero Import Corp. It is powered with the 300 hp. Fiat motor and weighs 2300 lb. empty. It carries a useful load of 1350 lb. including three hours fuel at a maximum speed of 130 m.p.h., and about four and one half hours at 100 m.p.h. The plane has a span of approximately 37 ft. Its low landing speed, high air speed, and the reliability of its power plant were the reasons for its being chosen to make the trip.

An Airplane that Vanished

According to western newspaper reports a complete airplane disappeared recently from the sheds of the Curtiss Aeroplane Co. of St. Paul, Minn. The machine was apparently stolen and no trace of it has as yet been found. A reward has been offered for the return of the missing airplane.

THE EARLY BIRD (HD-1 B)